

## REMARKS

Claims 1 and 7-26 were previously pending in the application. Claims 1, 7-16, 19, and 20 were withdrawn from consideration as directed to a non-elected invention and have now been canceled. Claim 17 has been amended, and claims 27-39 have been added.

Upon entry of the present amendment, claims 17, 18, and 21-39 are pending in the application. Claims 23-24 have been withdrawn as directed to a non-elected species.

Claim 17 has been amended to require that the process does not result in any reduction in molecular weight of the polyester (as supported at least on page 4, lines 30-31).

Entry of the above amendment is respectfully requested. The added limitation merely explicitly states an inherent characteristic of the present invention, as is clearly evident from the original application. Entry of the amendment is proper on the grounds that the amendment clearly places the application in condition for allowance.

1. **Rejection of claims 17-18, 21-22, and 25-26 under 35 U.S.C. §103(a) as obvious over Weikard et al., U.S. 6,150,458, hereafter “Weikard” in view of Kobayashi et al., “Enzymatic Polymerization,” hereafter “Kobayashi.”**

The Office Action states that Weikard discloses a process for the preparation of a (meth)acrylic acid ester by reacting a hydroxyl group containing polyester with (meth)acrylic acid in the presence of an esterification catalyst. The Office Action further states that Weikard points out that polymers obtained by the process can be used as radiation curable binders.

The Office Action concedes that Weikard is silent regarding conducting this process with an enzyme catalyst. 02/18/2009 Office Action page 3, para. 2.

The Office Action cites, therefore, Kobayashi for allegedly teaching a process of polymer modification, in which a terminal hydroxy group of a polyester reacts with carboxylic acid, that is catalyzed by a lipase enzyme catalyst in order to give end-functionalized polyester (citing page 3813, part 4, “Polymer Modification”). The Office Action further cites Kobayashi for “pointing out that enzymatic polymerization can be conducted under mild conditions without using toxic reagents by natural catalyst with ‘green’ appeal in commercial benefit and ecological

requirement,” citing page 3793, right column, third paragraph. 02/18/2009 Office Action page 3, para. 3. The Office Action alleges it would have been obvious to use the lipase catalyst teaching of Kobayashi in order to modify the polyester process of Weikard “under mild conditions without using toxic reagents....”

Applicants greatly appreciate the detailed basis of rejection but must respectfully disagree in regard to the inventions of independent claims 17, 27, and 36.

To briefly recap, the present invention is directed to the functionalization of a polymer containing at least one pendant and/or terminal group (at least two pending groups in independent claims 27 and 36) which can be activated with actinic radiation, which resulting functionalized polymer can be used for preparing a composition curable with actinic radiation. It was found that preparing such functionalized polyesters by conventional polymer-analogous reactions was problematic, since the direct reaction of hydroxyl-containing polyesters with carboxylic acids or carboxylic ester groups can lead to a cleavage of the polyester. Similarly, the reaction of polyesters containing carboxylic acid groups or carboxylic ester groups with hydroxyl-containing compounds such as hydroxyethyl acrylate can lead to a reduction in molecular weight.

On the other hand, the use of various enzymes in various polymerization reactions is known, as shown by Kobayashi. Whether and, if so, to what extent these reactions can be transferred to the preparation of a polyester containing groups that can be activated with actinic radiation were unknown. The predictability of enzymes or catalysts for new reactions is notoriously unpredictable, whereas the demands of, or requirements for, a commercially practical catalyst, especially to replace one in commercial practice, must be high. Not just any catalyst reaction to produce just any reaction will do. The reaction must be efficient, produce high yield and high conversion, produce the desired product and characteristics, not produce undesirable residues, not involve side reactions, not result in high viscosity due to unreacted groups, and the like. One particularly relevant feature is the effect of a catalyst on molecular weight and cleavage of the polymer involved in the reaction.

In the present invention, the object was to find polyesters containing at least one pendant and/or terminal group which can be activated with actinic radiation that no longer have the

disadvantages of the prior art, but which can instead be prepared by means of a process which does not involve any damage, in particular any reduction in molecular weight, of the polyesters, while having an advantageously low viscosity. In particular, it was desirable that the resulting functionalized polyesters show no damage caused by the preparation process, in particular no reduction in molecular weight.

The process of the claimed invention gave a product with no reduction in molecular weight of the polyesters. Moreover, by means of the process of the invention it was possible to gain outstanding reproduction of the profile of properties necessary for the particular end use. The compositions of the invention can be advantageously used as coating materials, particularly as topcoat materials or clearcoat materials. Such clearcoat materials are used for producing multicoat color and/or effect systems, especially multicoat color and/or effect paint systems using wet-on-wet techniques. Since the resultant clearcoats of the invention are the outermost coats of the multicoat paint systems, they essentially determine the overall appearance and protect the color and/or effect coats against mechanical and chemical damage and damage due to radiation. Consequently, deficiencies in the hardness, scratch resistance, chemical stability, and yellowing stability are manifested to a particularly severe extent in the clearcoat.

It was found that clearcoats using the enzyme-catalyzed functionalized polyesters of the present invention are highly scratch resistant and, after exposure to scratching, exhibit only very small losses of gloss. At the same time they exhibit high hardness, a particularly high chemical resistance, and adhere very firmly to the color and/or effect coats. Page 18, lines 11-20, of the original specification.

The Office Action is quite correct in citing Weikard for a process of preparing esters of (meth)acrylic acid. Weikard is directed, however, to solving certain problems that have nothing to do with enzyme catalysts. In fact, Weikard is evidence that enzymes are not used for such processes.

Weikard is directed to three problems. First, a stoichiometric excess of hydroxy groups produces undesirably high viscosities due to the residual concentration of hydroxyl groups in the polyester. Col. 1, lines 25-28. Second, the use of alkali metal hydroxides or tertiary amines as

esterification catalysts was found to be detrimental to the hardness and resistance of the resulting coatings. Col. 1, lines 29-37. Third, it was disadvantageous that the solvent had to be removed by distillation before the non-esterified (meth)acrylic acid could be reacted with epoxide-containing compounds. Col. 1, lines 43-46.

Weikard solved these problems by using an acid catalyst and reacting both the acid catalyst and the unreacted (meth)acrylic acid in the esterification solvent with oxirane compounds until an acid number of less than or equal to 5 mg KOH/g was obtained. Col. 1, lines 56-63. The solvent is then removed by distillation. The process is carried out in a solvent that is immiscible with water. Col. 2, lines 49-50.

In particular, Weikard discloses that suitable esterification catalysts include sulfuric acid, phosphoric acid, p-toluenesulfonic acid, and the like. (Col. 2, lines 39-48.) The process is conducted at a temperature of 60 to 140°C, preferably 70 to 120°C. Col. 3, lines 34-37. The claims of Weikard all require an acidic esterification catalyst, a reaction with an epoxide compound, and the presence of solvent. In particular, in the Examples in Weikard, the catalyst is p-toluenesulfonic acid, the solvent is isooctane (about 25 wt.%), the temperature of esterification is 100°C, and the acid number is about 5 mg KOH/g. Col. 4, lines 21-33.

Thus, Weikard cannot possibly teach the present invention. Weikard merely teaches a functionalized polyester produced by an entirely different process. Applicants are not contending that functionalized polyesters are not known, but that the claimed process produces functionalized polyesters in an entirely unexpected way and results in advantageous properties for use in automotive clearcoats and the like. Weikard says absolutely nothing about employing an enzyme to catalyze the transesterification or esterification of a polyester to functionalize a polyester with groups that can be activated with actinic radiation.

Nor can Kobayashi correct the clear deficiencies of Weikard. Kobayashi in general shows that various enzymes can be used in various polymerizations, which may be advantageous because of their “green” aspect. However, this is far from a sufficient teaching of the present invention, which obviously involves an unpredictable use of a particular class of enzyme catalysis in a

different context involving untried chemistry, i.e., different reactants, reactions, and process conditions.

The most relevant part of Kobayashi's lengthy 25-page monograph, cited on page 3813, is a three-paragraph section mentioning that lipase catalysts have been used for functionalizing polymers. However, this was in reference to specific reactions, either (1) the functionalization of a caprolactone polymer, poly( $\epsilon$ -CL), with carboxylic acids to give end-functionalized polyesters, or (2) the regioselective transesterification of the terminal ester group of oligo(methyl methacrylate) with allyl alcohol. However, the Office Action failed to note that Kobayashi goes on to state:

Under selected conditions, lipase could act as a hydrolytic degradation catalyst of polyesters...A low concentration of poly( $\epsilon$ -CL)...in toluene was readily subjected to degradation in the presence of lipase CA catalyst to give oligomers with molecular weights less than 500. The degradation behavior catalyzed by lipase was quite different than an acid-catalyzed degradation of random bond cleavage of polymer.

Thus, Kobayashi is far removed from the present invention, involving different polymers, low concentrations impractical for automotive finishes, a large amount of organic solvent which the present invention avoids, and degradation or cleavage of the polymer, contrary to the present invention. Kobayashi, if anything, would teach the inadequacy of lipase for use in preparing the functionalized polyesters of the present invention. In contrast, the present invention requires that the present process does not result in any reduction in molecular weight of the polyester. Furthermore, new claims 27 and 36 require that the polyester comprises at least two pendant, not merely terminal, groups that are activatable by actinic radiation so that it is advantageously useful in an automotive topcoat.

Furthermore, while Kobayashi relates to caprolactone polyesters at low concentrations in organic solvents, the present invention involves polyesters such as disclosed in German application DE 4204 518 A1, page 4, line 43, to page 5, line 2, as pointed out on page 9, lines 30-33, of the present specification. This German application corresponds to U.S. Patent No. 5,516,559, in which the polyester is described, in col. 4, lines 56-67, as comprising polyesters

prepared by reacting, among other monomers, polyols having more than two hydroxy groups. Such polyols, for example, trimethylolpropane (required in new claim 37) will result in pendant hydroxy groups in the polyester. The patent further states that the polyesters in general have hydroxyl numbers of 40-240. Likewise, in the present application, the polyester that is reacted, in the example on page 19, has a hydroxyl number of 180 mg KOH/g.

The other citations of Kobayashi in the Office Action were even less relevant, relating to polymerization, rather than functionalization of a polymer. In this regard, it should be noted that the term “transesterification” often refers to polymerization involving monomers, compared to the special use of the term in the present invention involving the attachment of a single monomer to an already formed polymer, wherein no polymerization occurs. In fact, transesterification is a term that has also been used for a process of reducing the molecular weight of polymers, either during polymerization or following polymerization.

For example, regarding claim 18, the Office Action refers to the formation of bio-degradable polyester from monomers under mild conditions. The Office Action quotes Kobayashi as stating

Many dicarboxylic acids and their alkyl esters are commercially available; however, they often showed low reactivity toward lipase catalyst. Thus...for efficient production of higher molecular weight polyesters....a horizontal two chamber reactor was employed to remove the leaving water molecules with molecular sieves. [Emphasis added.]

(02/18/2009 Office Action page 4, para. 1.)

Thus, the cited section to Kobayashi, on page 3810, refers to polymerization of monomers in which molecular weight is increased. To increase polymerization, removal of a reaction product can be used to increase yield. The situation is different where, as in the present invention, selective use of the enzyme is used to avoid cleavage of the polyester polymer to maintain the molecular weight of the polyester, without polymerization. Similarly, on pages 3806-07, Kobayashi merely states that lipases are stable in organic solvents as well as in living systems.

Regarding claim 25, the Office Action states that Kobayashi teaches that lipase “catalyzes the hydrolysis of fatty acid esters in living systems ....[and] can be used for esterification and transesterification,” citing the paragraph bridging pages 3806-3807. The Office Action further states that “specific lipases [such] as lipase CA... can catalyze polymerization of diacids and glycols,” citing page 3810, right column. [Emphasis added.] 02/18/2009 Office Action page 4, last para.)

Thus, the reference, in Kobayashi, to esterifications and transesterifications is with respect to polymerizations of monomers, not functionalization of an already formed polyester. This is clearly illustrated in Scheme 20 on page 3807. Finally, the “green” aspect of using enzymes in organic synthesis and its environmental appeal are merely general statements that, if used indiscriminately, would invalidate all patents directed to enzymatic reactions. The present invention does not involve the replacement of toxic reagents and there are no particular green aspects involved that serve any notable advantage in the present invention. The enzymes are used because they produce a polyester having advantageous properties that cannot be produced with conventional catalysts as in Weikard, as discussed above.

For an obviousness rejection to be proper, the Examiner must meet the burden of establishing that all elements of the invention are disclosed in the prior art; that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention, must contain some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combined references; and that the proposed modification of the prior art will have a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988); *In Re Wilson*, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970).

To establish *prima facie* obviousness of a claimed invention, three basic criteria must be met. *See* MPEP § 2143. First, the prior art references must teach or suggest all of the claim limitations. *See id.*

Furthermore, the combined references of Weikard and Kobayashi fail to suggest a polyester having (as required by independent claims 27 and 36) at least two pendant groups which can be activated with actinic radiation, which polyester is functionalized in the presence of an enzyme that catalyzes the transesterification or esterification of that particular reaction.

The requirement for a determination of obviousness is that "both the suggestion and the expectation of success must be founded in the prior art, not in applicant's disclosure" (emphasis added). *In re Dow Chem.*, 837 F.2d 469, 473, 5 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1988). Furthermore, there must be a reasonable expectation of success. At the time of the patentee's invention, a person of ordinary skill in the art must have had a reasonable expectation of success in combining the cited references to produce Applicants' required process for producing particular actinically curable polyesters. In this case, those of ordinary skill in the art would appreciate the unpredictability of a novel and untried catalyst for the functionalization of polymers having terminal or pendant groups and would also appreciate that the polymer might be vulnerable to degradation by the catalyst, especially an enzyme catalyst, a problem mentioned by Kobayashi. In this case, nothing in Kobayashi indicates that it would be possible to retain the molecular weight of the polyester while effectively functionalizing the polyester to obtain a pendant or terminal group that is actinically activatable. In fact, the contrary is suggested.

Taken as a whole, it is respectfully submitted that the cited combination fails to provide the requisite motivation for a prima facie case of obviousness.

Reconsideration and removal of the obviousness rejection of claims 17, 18, 21-22, and 25-26 are respectfully requested in view of the foregoing remarks.

New Claims:

New claims 27-39 are presented to further distinguish from the invention. In particular, new independent claim 27 contains all the limitations of claim 17 and further specifically requires that the polyester contains at least two pendant hydroxyl groups that are reacted with an ester of a carboxylic acid having a double bond activatable by actinic radiation, as supported on page 5, lines 21-23, and page 6, lines 7-18. Claim 27 further requires that the

enzyme is selected from the group consisting of hydrolases that are carboxylester hydrolases (as supported by dependent claim 24); claim 27 further requires that the reactions are carried out at a temperature of 15 to 75°C (as supported on page 12, lines 13-19); wherein the water produced during the esterification of the polyester or the resultant hydroxyl-containing compounds is or are removed from the reaction mixture as they are forming or immediately after they have formed, as supported on page 13, lines 2-13. Finally, claim 27 further states that the resulting polyester is capable of use as a coating material in an outermost coat of a multicoat paint system, as supported by page 18, lines 11-14.

New independent claim 36 contains all the limitations of claim 27 and further requires that the ester of the carboxylic acid is an ester of acrylic acid or methacrylic acid (as supported on page 11, lines 16-20) and the enzyme is a lipase catalyst obtained from at least one of *Achromobacter* sp., *Aspergillus* sp., *Burkholderia* sp., *Candida* sp., *Mucor* sp., *Penicillium* sp., *Pseudomonas* sp., *Rhizopus* sp., *Thermomyces* sp., and porcine pancreas, as supported on page 8, lines 30-33.

New dependent claims 28-29 are supported by dependent claims 14-15. Claim 30 is supported on page 30, lines 10-14. New claim 32 requires that the reaction is carried out in bulk without the addition of organic solvents or in the presence of small amounts, as supported on page 12, lines 9-11. Claim 33 requires that the process is carried out at a temperature of 20 to 70°C, as supported on page 12, lines 13-19. Claim 34 requires that an absorbent, specifically a molecular sieve (Claim 35), is used to remove hydroxyl-containing compound or water that forms from the reaction mixture during or immediately after its formation in the process, as supported on page 13, lines 1-13.

New dependent claims 37-39 require that the polyester comprises the reaction product of a trimethylolpropane monomer, a phthalic anhydride monomer, or a neopentylglycol and hexanediol monomer, as supported on page 19, lines 1-6.

## **CONCLUSION**

Applicants respectfully submit that the Application and pending claims are patentable in view of the foregoing amendments and/or remarks. A Notice of Allowance is respectfully requested. As always, the Examiner is encouraged to contact the Undersigned by telephone if direct conversation would be helpful.

Respectfully Submitted,

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Tuesday, April 07, 2009  
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